NASA/TM—2003–212253

Bio-Optical and Geochemical Properties of the South Atlantic Subtropical Gyre

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December 2003

1. Introduction

An investigation of the bio-optical properties of the South Atlantic subtropical gyre (SASG) was conducted using data primarily from the UK Atlantic Meridional Transect (AMT) program and SeaWiFS. The AMT cruises extend from the UK to the Falklands Islands (sailing on the RRS *James Clark Ross*) with the purpose of improving our knowledge of surface layer hydrography, biogeochemical processes, ecosystem dynamics and food webs across basin scales in the Atlantic Ocean [*Aiken et al.*, 2000]. Two objectives of the AMT program relevant to this study are the characterization of biogeochemical provinces and the analysis of optical and pigment parameters in connection with remote sensing ocean color data.

The primary focus of this NASA Technical Memorandum is on the variability of the vertical distribution of phytoplankton pigments and associated absorption properties across the SASG, and their relevance to remote sensing algorithms. Therefore, a subset of the AMT data within the SASG from all available cruises was used in the analyses. One of the challenges addressed here is the determination of the SASG geographic boundaries. One of the major problems is to reconcile the properties of biogeochemical provinces [*Longhurst et al.*, 1995] with the boundaries of physical provinces [*Hooker et al.*, 2000b]. We use water mass analysis, dynamics of ocean currents, and meridional gradients of bio-optical properties, to identify the SASG boundaries.

The variability of the sea-air pCO_2 difference (ΔpCO_2) and corresponding CO_2 flux are also analyzed in this TM. Atmospheric and oceanic pCO_2 were measured continuously [*Lefevre and Moore*, 2000] along an AMT transect (50°N-50°S) in September-October 1995 and 1996 (UK to the Falklands Islands) and in April-May 1996 (Falklands Islands to the UK). Based on data from these three AMT cruises, and data from two other cruises (M/V *Prince of Seas* sailing from UK to Jamaica and RMS *St. Helena* sailing from UK to South Africa), *Lefevre and Taylor* [2002] developed a pCO_2 algorithm for the North Atlantic and South Atlantic gyres. We used the pCO_2 algorithm to estimate the seasonal variability of ΔpCO_2 and sea-air CO_2 flux in the SASG.

2. Data Sources and Methods

A variety of data sources were used in this study. However, the major sources were the AMT cruises and SeaWiFS data. The AMT cruises (Table 1) provided the bulk of the *in situ* data analyzed. These included CTD and XBT data, nutrients, pigments, and apparent optical properties (AOP) of seawater covering the majority of the SeaWiFS channels. The only pigment analyzed in this study is the total chlorophyll *a*, defined as TChl *a* = [chlorophyllide *a* + divinyl chlorophyll *a* + chlorophyll *a*]. Other ancillary data sets were used to complement the analyses. Climatological temperature and salinity data from the World Ocean Atlas 98 (WOA98) [*Conkright et al.*, 1998] were used to derive dynamic height and geostrophic currents. WOA98 salinity data were used for calculating CO_2 solubility and weekly SST global fields [*Reynolds and Smith*, 1994] were used in conjunction with the pCO_2 algorithm. Long records of atmospheric CO_2 (Atm_pCO_2) are not available for the South Atlantic. Therefore, monthly 10-year records (July 1991 – December 2001) of atmospheric pCO_2 concentrations from the CSIRO GASLAB flask sampling network in the South Pacific, were used to produce weekly Atm_pCO_2 interpolated in latitude at 1° resolution to conform with the SST grid.